

1 **CLAIMS**

2 1. A method comprising:

3 providing at least one time-stamped data stream that is to be rendered in
4 accordance with data stream timestamps; and

5 synchronizing said at least one time-stamped data stream relative to a
6 reference by adjusting one or more timestamps of said at least one time-stamped
7 data stream.

8
9 2. The method of claim 1, wherein the reference comprises another
10 time-stamped data stream.

11
12 3. The method of claim 1, wherein the reference comprises a reference
13 clock.

14
15 4. The method of claim 1, wherein the act of synchronizing comprises
16 doing so periodically.

17
18 5. The method of claim 1, wherein the act of synchronizing comprises
19 determining whether said at least one time-stamped data stream is within a defined
20 tolerance and, if not, performing said act of synchronizing.

21
22 6. The method of claim 1, wherein said at least one time-stamped data
23 stream comprises a video stream.

1 7. The method of claim 1, wherein said at least one time-stamped data
2 stream comprises an audio stream.

3

4 8. The method of claim 1, wherein said at least one time-stamped data
5 stream comprises a video stream and an audio stream.

6

7 9. A method comprising:

8 providing a filter graph comprising multiple filters, the filter graph being
9 configured to process multiple timestamped data streams for rendering the data
10 streams in accordance with data stream timestamps; and

11 synchronizing said at least one time-stamped data stream relative to a
12 reference by adjusting one or more timestamps of said at least one time-stamped
13 data stream.

14

15 10. The method of claim 9, wherein the act of synchronizing comprises
16 instructing one or more of the filters to adjust at least one timestamp associated
17 with at least one data sample of one or more of the data streams.

18

19 11. The method of claim 10, wherein the act of instructing comprises
20 instructing one or more decoder filters to adjust at least one timestamp associated
21 with at least one data sample.

22

23 12. The method of claim 9, wherein the reference comprises another
24 time-stamped data stream.

1 **13.** The method of claim 9, wherein the reference comprises a reference
2 clock.
3

4 **14.** The method of claim 9, wherein the act of synchronizing comprises
5 doing so periodically.
6

7 **15.** The method of claim 9, wherein the act of synchronizing comprises
8 determining whether said at least one time-stamped data stream is within a defined
9 tolerance and, if not, performing said act of synchronizing.
10

11 **16.** One or more computer-readable media comprising instructions
12 which, when executed by one or more processors, cause the one or more
13 processors to implement the method of claim 9.
14

15 **17.** A method comprising:
16

17 providing a filter graph comprising multiple filters, the filter graph being
18 configured to process multiple timestamped data streams for rendering the data
19 streams in accordance with data stream timestamps;
20

21 providing a synchronization module associated with the filter graph, the
22 synchronization module being configured to:
23

24 query individual filters of the filter graph to ascertain input
25 timestamp-to-output timestamp mappings,
26

27 compute adjustments that are to be made to output timestamps in
28 order to synchronize the data streams, and
29

1 instruct individual queried filters to adjust their output timestamps in
2 accordance with computed adjustments;

3 querying individual filters of the filter graph, using the synchronization
4 module, to ascertain input timestamp-to-output timestamp mappings;

5 computing, based on the ascertained input timestamp-to-output timestamp
6 mappings, adjustments that are to be made to output timestamps in order to
7 synchronize the data streams; and

8 synchronizing the data streams by instructing one or more of the queried
9 filters to adjust their output timestamps in accordance with the computed
10 adjustments.

11
12 **18.** The method of claim 17, wherein the act of synchronizing comprises
13 doing so periodically.

14
15 **19.** The method of claim 17, wherein the act of synchronizing comprises
16 determining whether the multiple time-stamped data streams are within a defined
17 tolerance and, if not, performing said act of synchronizing.

18
19 **20.** The method of claim 17, wherein the act of querying comprises
20 querying individual filters for a current input timestamp and a current output
21 timestamp.

1 **21.** The method of claim 20, wherein the act of computing comprises:
2 extrapolating at least one curve characterizing the timestamp mappings for
3 at least one of the timestamp mappings to a defined point corresponding to a
4 common input timestamp; and
5 computing said adjustments based on the extrapolated line(s).

6

7 **22.** The method of claim 21, wherein the act of extrapolating comprises
8 performing a linear extrapolation.

9

10 **23.** The method of claim 21, wherein the defined point comprises the
11 largest value of an input timestamp returned by the act of querying.

12

13 **24.** The method of claim 21, wherein the act of computing comprises
14 computing a skip value by taking the difference between the largest output
15 timestamp value at the common input timestamp and the output timestamp value
16 for said at least one curve at the common input timestamp.

17

18 **25.** The method of claim 24, wherein the act of instructing comprises
19 instructing one or more filters to jump their output timestamp values by an
20 associated skip value at the common input timestamp.

21

22 **26.** An architecture comprising:
23 a filter graph comprising multiple filters, the filter graph being configured
24 to process multiple timestamped data streams for rendering the data streams in
25 accordance with data stream timestamps; and

1 a synchronization module associated with the filter graph, the
2 synchronization module being configured to:

3 query individual filters of the filter graph to ascertain input
4 timestamp-to-output timestamp mappings,

5 compute adjustments that are to be made to output timestamps in
6 order to synchronize the data streams, and

7 instruct the queried filters to adjust their output timestamps in
8 accordance with its adjustment computations.

9
10 **27.** The architecture of claim 26, wherein the synchronization module is
11 configured to periodically instruct one or more of the queried filters to adjust their
12 output timestamps.

13
14 **28.** The architecture of claim 26, wherein the synchronization module is
15 configured to determine whether the multiple time-stamped data streams are
16 within a defined tolerance and, if not, at least instruct one or more of the queried
17 filters to adjust their output timestamps.

18
19 **29.** The architecture of claim 26, wherein the synchronization module is
20 configured to query individual filters for a current input timestamp and a current
21 output timestamp.

1 **30.** The architecture of claim 29, wherein the synchronization module is
2 configured to compute adjustments by:

3 extrapolating at least one curve characterizing the timestamp mappings for
4 at least one of the timestamp mappings to a defined point corresponding to a
5 common input timestamp; and

6 computing said adjustments based on the extrapolated line(s).

7
8 **31.** The architecture of claim 30, wherein the synchronization module is
9 configured to linearly extrapolate said at least one curve.

10
11 **32.** The architecture of claim 30, wherein the defined point comprises
12 the largest value of an input timestamp returned by querying the one or more
13 filters.

14
15 **33.** The architecture of claim 30, wherein the synchronization module is
16 configured to compute adjustments by taking the difference between the largest
17 output timestamp value at the common input timestamp and the output timestamp
18 value for said at least one curve at the common input timestamp.

19
20 **34.** The architecture of claim 33, wherein the synchronization module is
21 configured to instruct one or more filters to jump their output timestamp values by
22 an associated skip value at the common input timestamp.

1 **35.** One or more computer-readable media having computer-readable
2 instructions thereon which, when executed by one or more processors, cause the
3 one or more processors to:

4 query one or more filters configured to process timestamped data streams
5 for each filter's input timestamp-to-output timestamp mapping;

6 receive responses from the queried filters;

7 extrapolate one or more lines characterizing an individual mapping to a
8 selected input timestamp value;

9 calculate a skip value for one or more of the lines, a skip value representing
10 a value by which the output timestamps for a given filter are to be corrected; and

11 provide instructions to one or more of the filters to adjust their output
12 timestamps in accordance with an associated skip value.

13
14 **36.** The computer-readable media of claim 35, wherein the instructions
15 cause the one or more processors to query the one or more filters for each filter's
16 data stream playback rate.

17
18 **37.** The computer-readable media of claim 35, wherein the instructions
19 cause the one or more processors to query one or more decoders filters.

20
21 **38.** The computer-readable media of claim 35, wherein the instructions
22 cause the one or more processors to linearly extrapolate the one or more lines.

1 **39.** The computer-readable media of claim 35, wherein the selected
2 input timestamp value comprises a current input timestamp value for one of the
3 filters.

4

5 **40.** The computer-readable media of claim 35, wherein the selected
6 input timestamp value comprises a future input timestamp value.

7

8 **41.** One or more computer-readable media having computer-readable
9 instructions thereon which, when executed by one or more processors, cause the
10 one or more processors to:

11 define a skip value tolerance that can be used to ascertain when
12 synchronization processing of multiple data streams should take place;

13 ascertain whether any input timestamp-to-output timestamp mappings
14 associated with any of the multiple data streams meet or exceed the skip value
15 tolerance; and

16 synchronize the multiple data streams if any input timestamp-to-output
17 timestamp mappings meet or exceed the skip value tolerance.

18

19 **42.** The computer-readable media of claim 41, wherein the instructions
20 cause the one or more processors to synchronize to a common data stream.

21

22 **43.** The computer-readable media of claim 41, wherein the instructions
23 cause the one or more processors to synchronize to a reference clock.

1 **44.** The computer-readable media of claim 41, wherein one of the
2 multiple data streams comprises a video stream.
3

4 **45.** The computer-readable media of claim 41, wherein one of the
5 multiple data streams comprises an audio stream.
6

7 **46.** The computer-readable media of claim 41, wherein one of the
8 multiple data streams comprises a video stream and another of the multiple data
9 streams comprises a video stream.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25